



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Pondicq-Cassou
Serial No.: 10/646,253
Filed: August 22, 2003
Group Art Unit: 3744
Examiner: Jiang, Chen Wen
Title: DEFROSTING METHODOLOGY FOR HEAT PUMP WATER HEATING SYSTEM

Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

Dear Sir:

DECLARATION UNDER 37 C.F.R. § 1.131

We, Nicolas Pondicq-Cassou, Jean-Philippe Goux, Yu Chen, Julio Concha, Tobias Sienel and Sylvain Douzet, state as follows:

- 1) We are inventors of the invention described in United States Patent Application Serial No. 10/646,253.
- 2) Applicant actually reduced to practice the invention at least as early as March 27, 2003. A copy of the Idea Record written by the inventors describing the invention is attached as Exhibit A. The date of the actual reduction to practice is prior to March 27, 2003. The invention actually existed and worked for its intended purpose prior to March 27, 2003.
- 3) I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Dated: 14th of March 2005



Nicolas Pondicq-Cassou

Dated: March 14th, 2005



Jean-Philippe Goux

Dated: _____

Yu Chen

Dated: _____

Julio Concha

Dated: _____

Tobias Sienel

Dated: March 14th 2005



Sylvain Douzet


Dated: _____

Jean-Philippe Goux

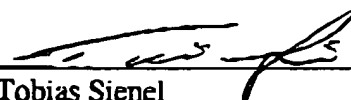
Dated: 3/12/2005


Yu Chen

Dated: 3/14/2005


Julio Concha

Dated: 3/14/2005


Tobias Siemel

Dated: _____

Sylvain Douzet

MAR 24 2005

UTRC INVENTION DISCLOSURE ROUTING SLIP

TO BE COMPLETED BY INVENTOR: Please Enter The Title of the Invention, Names Of Inventor(s), and Names Of Division Program Leader(s) (DPL(s)) for the Business Unit(s) ("BU") listed in question 4(a) of the UTRC Invention Questionnaire.

TITLE: DEFROSTING METHODOLOGY FOR CO2 HEAT PUMP WATER HEATING SYSTEM

INVENTOR(S): NICOLAS PONDICQ-CASSOU, JEAN PHILIPPE GOUX, YU CHEN, JULIO CONCHA, TOBIAS SIENEL

DPL Name: BILL SISSON

BU: CARRIER

***Initials:** WJ

***Date:** _____

DPL Name: _____

BU: _____

***Initials:** _____

***Date:** _____

DPL Name: _____

BU: _____

***Initials:** _____

***Date:** _____

Docket: 10,678

CAR 016737

SHADED AREAS TO BE COMPLETED BY DIVISION PROGRAM LEADER (DPL)

You have been sent the attached original Invention Disclosure and UTRC Invention Questionnaire because the invention may benefit the Business Unit ("BU") for which you are responsible. The purpose of your review at this time is mainly informational. Within two weeks of receipt:

1. Please review the Invention Disclosure and initial and date in the space provided above.
2. In Item 1-(d) of the UTRC Invention Questionnaire, the inventors of the present invention were asked to list the names of the individuals at the BU who should be contacted to evaluate this invention. If you believe that additional individuals at the BU should be contacted, please list their names and association below.

Additional Evaluator Name: _____ **Business Unit:** _____

Additional Evaluator Name: _____ **Business Unit:** _____

Additional Evaluator Name: _____ **Business Unit:** _____

3. If you are the only or last listed DPL, please forward this package to the UTRC Law Department at the address indicated at the bottom of the page. The UTRC Law Department will forward the attached to the relevant BU(s) for adoption. The BU(s) will, in turn, decide whether it is interested in adopting this invention. As a DPL for a BU that may benefit from the invention, if you feel that such BU should adopt the invention, you are encouraged to contact that BU and apprise the appropriate individuals of your views.

4. If you are not the only or last listed DPL, please forward this package to the next listed DPL. As a DPL for a BU that may benefit from the invention, if you feel that such BU should adopt the invention, you are encouraged to contact that BU and apprise the appropriate individuals of your views.

Last listed DPL: Forward The "Routing Slip, Questionnaire and Disclosure" To:

UTRC LAW DEPARTMENT
MS 129-6
ATTENTION: LORETTA N. LAWRENCE

DEFROSTING METHODOLOGY FOR CO2 HEAT PUMP WATER HEATING SYSTEM

BACKGROUND

The CO2 heat pump commercial water heating system utilizes a compressor, a gas cooler, an electronic expansion valve (EXV), and an evaporator with a fan to transfer heat energy from a low temperature energy reservoir to a high temperature energy sink. This transfer is achieved with the aid of electrical energy input at the compressor. A temperature difference between the outdoor air and the refrigerant drives the thermal energy transfer from the air to the working fluid as it passes through the evaporator. The fan continues to move fresh air across the evaporator surface, maintaining the temperature difference, and evaporating the refrigerant. If the surface temperature of the evaporator is below the dew-point temperature of the moist air stream, water will condense onto the fins. When the surface of the evaporator is below freezing, water droplets that condense on the surface can freeze. Frost crystals then grow from the frozen droplets and begin to block the airflow passage through the evaporator fins. The blockage increases the pressure drop through the evaporator, which reduces the airflow. As a result of the insulating effect of frost and blockage of airflow, the refrigerant temperature in the evaporator decreases, which ultimately causes degradation in the heat pump performance and reduction of the heating capacity. Eventually, a defrost cycle must be initiated.

INVENTION

The heat pump utilizes a switching valve to connect the compressor discharge to the EXV inlet to perform the defrost cycle, as shown in *Figure 1*. During the defrost cycle, the switching valve should be open to bypass the high temperature refrigerant from the compressor discharge to the EXV inlet. Water pump should be shut off to stop extracting heat from the CO2. The switching valve should be sized properly so that the pressure drop through the switching valve is much less than the gas cooler. Therefore, most of the refrigerant will be flowing through the switching valve to the EXV. The hot CO2 is then throttled by the EXV and sent to the evaporator. The high temperature refrigerant in the evaporator can heat the evaporator and eliminate the frost. During the defrost cycle, the EXV will be controlled to maximize the compressor power, thereby speeding up the defrosting process.

A pressure-enthalpy diagram is shown in *Figure 2* for a defrost cycle at one ambient condition.

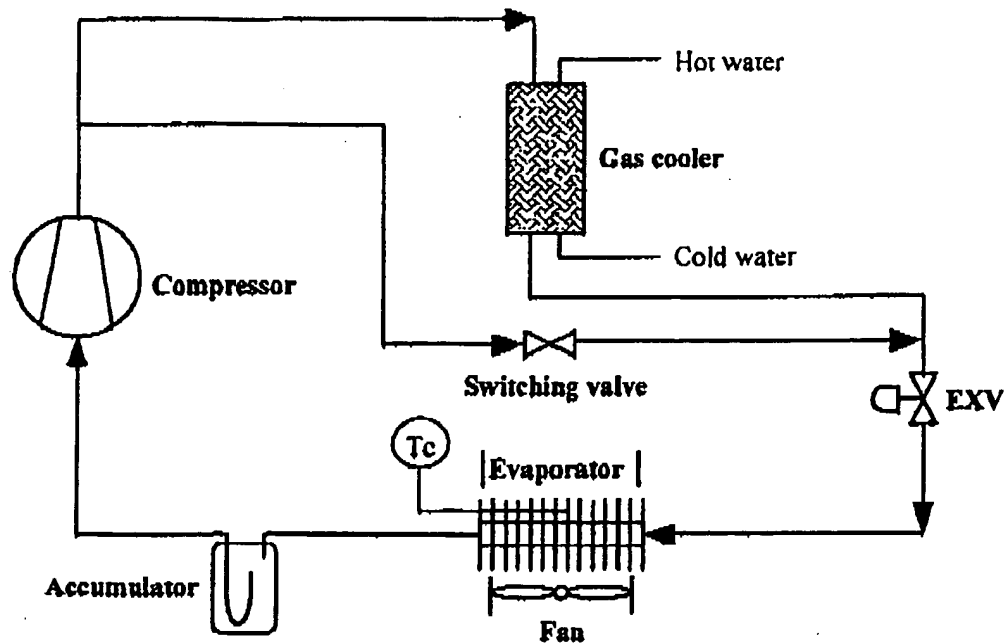


Figure 1 Schematic of the CO₂ heat pump commercial water heating system

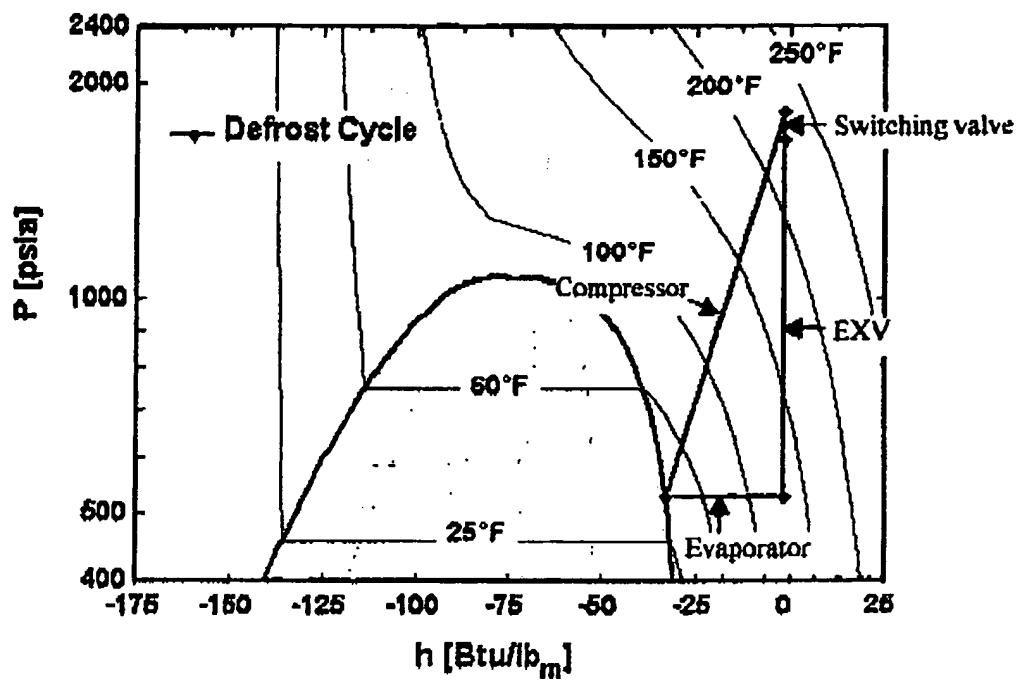



Figure 2 A pressure-enthalpy diagram of the CO₂ heat pump defrost cycle

Inventor's signature

**NICOLAS PONDICQ-
CASSOU**

Inventor's printed name


Inventor's signature

JEAN PHILIPPE GOUX

Inventor's printed name

Inventor's signature


YU CHEN

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Explained to and understood by:

Witness #1's signature

Bryan Ebenhaier
Witness #1's printed name

Witness #2's signature

Witness #2's printed name

UTRC INVENTION QUESTIONNAIRE

Title of Invention:	DEFROSTING METHODOLOGY FOR CO ₂ HEAT PUMP WATER HEATING SYSTEM		
Program Name:	CO ₂ Heat Pump Water Heating	Division Program Leader(s):	William Sibbo
TO BE FILLED OUT BY LAW DEPARTMENT		DOCKET NUMBER:	

1. Specific development of this invention:

- (a) When did you conceive this invention? Date: _____ Project No.: 2.402.0001
 To which project were you charging your time? _____
- (b) Has the invention been successfully built or tested? Yes ☒ No ☐
 • If yes, when? _____ How? Experiments on CO₂ heat pump system
 • If no, what future effort is planned to build or test this invention? _____
 • What business unit, government agency, or customer will sponsor the testing? _____

2. UTRC Contract and proposal information (include both government and commercial contracts):

- Was the invention conceived or successfully built or tested in the performance of work under: Yes ☐ No ☒
 • A UTRC Prime Government Contract or a Commercial Contract/Agreement: _____
 Gov't Contract #: _____ or Commercial Contract/Agmt #: _____
 Gov't Agency or Customer Name: _____
- A UTRC Subcontract under a non-UTRC Prime Government Contract: Yes ☐ No ☒
 Subcontract #: _____ Customer Name: _____
- An Interdivisional Work Authorization (IDWA): Yes ☐ No ☒
 UTRC Business Unit: _____ Business Unit Gov't Contract #: _____

3. Disclosure of invention outside UTRC:

- (a) Has the invention been disclosed to others outside UTRC, or included in any printed publications, seminars, presentations, trade shows, exhibits? Yes ☐ No ☒
 (b) If yes, disclosed to whom and under what circumstances? _____
 (c) Date of disclosure: _____

4. Business Unit Information:

- (a) UTC Business Units that may be interested in this invention: Carrier
- (b) Names of individual(s) at each Business Unit who should be contacted to evaluate invention:
NICK PONDICQ - CASSO
- (c) Current or potential uses/products: Vapor compression heat pump systems

	Inventor #1	Inventor #2	Inventor #3
Inventor(s) signature:			
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Business Unit:	Carrier	Carrier	UTRC
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Inventor(s) signature:			
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